CULTIVAR DESCRIPTION

Lillian hard red spring wheat

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DePauw, R. M., Townley-Smith, T. F., Humphreys, G., Knox, R. E., Clarke, F. R. and Clarke, J. M. 2005. **Lillian hard red spring wheat**. Can. J. Plant Sci. **85**: 397–401. Lillian, hard red spring wheat (*Triticum aestivum* L.), exhibited reduced cutting by the wheat ste m sawfly (*Cephus cinctus* Nort.) and is adapted to the Canadian prairies. Lillian produced significantly more grain yield than AC Abbey and Neepawa and its grain yield and protein concentration were similar to AC Barrie. It matured significantly earlier than Superb and Laura, and had improved resistance to leaf rust and leaf spotting diseases compared to AC Abbey. Lillian is eligible for all grades of the Canada Western Red Spring (CWRS) wheat class.

Key words: *Triticum aestivum* L., cultivar description, grain yield and protein, resistance wheat stem sawfly, leaf and stem rust

DePauw, R. M., Townley-Smith, T. F., Humphreys, G., Knox, R. E., Clarke, F. R. et Clarke, J. M. 2005. **Lillian: blé de force roux de printemps**. Can. J. Plant Sci. **85**: 397–401. Lillian est un blé de force roux de printemps (*Triticum aestivum* L.) qui démontre moins de tiges coupées par la tentrèdre (*Cephus cinctus* Nort.). Il est adapté pour la production céréalière dans les provinces canadiennes de l'ouest. Lillian produit un rendement en grains significativement plus élévé que ceux de AC Abbey et Neepawa; son rendement en grains et sa concentration en protéines sont semblables à ceux de AC Barrie; est plus hâtif que Superb et Laura; et a une meilleure résistance contre la rouille brune et autres maladies foliaires. Lillian se qualifie pour tous les grades de la classe: blé roux de printemps de l'Ouest canadien (CWRS).

Mots clés: *Triticum aestivum* L., description du cultivar, rendement en grains et protéines, résistance contre la tenthrède, la rouille brune et la rouille noire

Lillian, hard red spring wheat (*Triticum aestivum* L.) was developed jointly at the Cereal Research Centre (CRC), Agriculture and Agri-Food Canada (AAFC), Winnipeg, MB, and the Semiarid Prairie Agricultural Research Centre (SPARC), AAFC, Swift Current, SK. It received a restricted registration No. 5689 from the Variety Registration Office, Food Production and Inspection Branch, Canadian Food Inspection Agency on 2003 Sep. 04.

Pedigree and Breeding Method

Lillian derives from the cross BW621*3/90B07-AU2B made in 1995 at the CRC, AAFC, Winnipeg. BW621 is an experimental line, that is resistant to the wheat stem sawfly (*Cephus cinctus* Nort.), and was developed at SPARC from the cross Leader/7504-78//7504-59 (DePauw and McLeod 1989). It expressed high grain yield potential, but had inadequate grain protein content to be eligible for registration as a CWRS cultivar. The 90B07-AU2B is a breeding line developed at CRC from the cross Pasqua*2/ND643 that has high protein content and the DNA marker associated with the high protein content of ND643 (Khan et al. 2000). Eight F_1 plants from the cross BW621*2/90B07-AU2B, selected using a DNA marker associated with the high protein content of ND643, were backcrossed to BW621 and the resulting BC_2F_1 plants were also selected using the high protein marker. Doubled haploid (DH) lines were derived from the selected BC_2F_1 population using the wheat by maize hybridization technique. In the winter of 1996–1997, 156 DH lines were increased in New Zealand and subsequently tested for agronomic performance, rust resistance and protein content at four locations in Manitoba in 1997. In 1998, selected lines were transferred to SPARC, and grown in the Western Bread Wheat "A4" test with three replications at five locations.

In 1999, the DH experimental line 95B23*NE16 was selected and evaluated in the Western Bread Wheat 'B' test at seven locations and from 2000 to 2002 it was evaluated in the Western Bread Wheat Cooperative (WBWC) test as BW776. The check cultivars in the WBWC test for the 3 yr were AC Barrie, AC Abbey, and Laura. Neepawa was used as check cultivar in 2000 but it was replaced by Katepwa in 2001. Similarly, AC Elsa was used as a check cultivar in 2000 and 2001, and was replaced by Superb in 2002. The variables measured and the protocols followed in the WBWC test have been described by Graf and Fox (2000). Each year the data were analyzed using the S506 statistical program developed by the Statistical Research Services,

Abbreviations: **CWRS**, Canada Western Red Spring; **DH**, doubled haploid; **WBWC**, Western Bread Wheat Cooperative

Table 1. Response of Lillian and check varieties to cutting by the Wheat Stem Sawfly, based on data from the Western Bread Wheat Co-operative tests, 2000–2002

	%Sawfly cutting			
	2000 SC[z]	2001 SC	2002 SC	Skiff[z]
Katepwa	–	14	18	70
Laura	18	9	12	85
AC Barrie	24	16	15	78
AC Elsa	19	8	–	–
AC Abbey	9	5	5	6
Lillian	11	8	7	4
$LSD_{0.05}$	9	10	13	16
Reps	4	4	4	4

[z]SC and Skiff are specialized nurseries to assess percent cutting by the wheat stem sawfly near Swift Current, SK, and near Skiff, AB.

AAFC. SAS GLM (SAS Institute, Inc. 1999) was used to perform a combined analysis over years, using a mixed model with environments and replications as random and genotypes as fixed variable.

During the WBWC testing period, leaf and stem rust seedling infection types were assessed by pathologists at the Cereal Research Centre, AAFC, Winnipeg, MB. Stem rust races used for 1 or more years were: QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2003). Leaf rust races used for 1 or more years were: MBDS (12-3), MBDS (185-1), MBRJ (128-1), MGBJ (74-2), and TJBJ (77-2) (McCallum and Seto-Goh 2003). Field evaluations of both leaf and stem rust reactions, using the same races as for the seedling tests, were measured in an epiphytotic nursery

Table 2. Agronomic performance of Lillian compared to the check cultivars, based on data from the Western Bread Wheat Cooperative test (2000–2002)[z]

	Yield (kg ha $^{-1}$)				Maturity (d)			
	2000	2001	2002	Mean	2000	2001	2002	Mean
Neepawa	4148				101.6			
Katepwa		2755	2957			97.9	103.4	
Laura	4479	2772	3224	3509	104.0	99.2	104.4	102.5
AC Abbey	4400	2554	3045	3352	101.7	98.2	101.6	100.5
AC Barrie	4467	2761	3253	3509	102.2	98.0	103.6	101.2
AC Elsa	4636	2673			101.7	98.5		
Superb			3427				105.2	
Lillian	4512	2832	3405	3594	102.1	98.4	103.5	101.3
LSD[y]	258	171	322	228	1.5	0.8	1.3	1.1
No. tests	11	11	9	31	10	9	8	27

	Height (cm)				Lodging (1–9)[x]			
	2000	2001	2002	Mean	2000	2001	2002	Mean
Neepawa	101				2.5			
Katepwa		76	75			3.0	2.2	
Laura	99	73	77	84	2.9	2.0	3.8	3.1
AC Abbey	92	70	70	78	2.1	2.7	4.0	2.8
AC Barrie	97	75	74	83	1.5	2.0	2.0	1.7
AC Elsa	97	73			1.6	2.0		
Superb			73				1.6	
Lillian	96	73	75	82	2.4	3.0	4.3	3.1
LSD	3.1	2.7	1.3	2.8	0.7	0.4	1.5	0.4
# Tests	10	9	8	27	5	1	3	9

	Kernel size (mg)				Test weight (kg hL^{-1})			
	2000	2001	2002	Mean	2000	2001	2002	Mean
Neepawa	31.2				80.0			
Katepwa		31.2	30.9			81.0	76.8	
Laura	32.9	32.3	31.4	32.3	80.3	81.2	77.6	79.8
AC Abbey	33.3	32.5	31.9	32.6	80.4	81.1	76.8	79.6
AC Barrie	35.1	34.3	34.1	34.5	81.4	81.6	78.3	80.5
AC Elsa	33.5	32.1			80.8	81.4		
Superb			38.8				79.4	
Lillian	35.3	33.4	33.9	34.2	80.3	80.6	77.2	79.5
LSD	2.3	3.3	4.7	1.0	1.5	1.3	2.2	0.5
No. tests	11	10	9	30	11	10	9	30

[z]Locations in the Western Bread Wheat Cooperative tests included: Elrose, Indian Head, Irricana, Kernen, Kindersley, Lacombe, Lethbridge, Melfort, Regina, Scott, Swift Current, Watrous.
[y]Least significant difference. $P \leq 0.05$, based on the mean squares genotype by environment interaction.
[x]A rating scale of 1 to 9 with a rating of 1 indicating all plants in a plot were vertical and 9 indicating all plants in a plot were horizontal.

Table 3. Grain yield (kg ha^{-1}) and protein concentration (%) of Lillian and other cultivars based on data from the 2002 Saskatchewan Advisory Council on Grain Crops

	Zone 1		Zone 2		Zone 3		Zone 4		Irrigated		Province	
	Yield[z]	Protein[y]	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
AC Barrie	2597	13.4	3844	13.2	2941	15.0	1919	14.0	5736	15.4	3153	14.2
CDC Bounty	2649	13.4	3701	13.2	2841	14.8	1965	13.6	4835	15.5	3071	14.1
Journey	2615	13.6	3578	13.8	2944	15.0	1804	13.8	4864	16.1	3068	14.5
Harvest	2504	13.0	3728	12.9	2844	14.3	1850	13.8	3883	15.1	2970	13.8
Lovitt	2696	13.4	3671	13.4	2817	15.0	2138	13.7	5117	16.1	3106	14.3
Superb	2711	13.0	4239	13.4	3182	14.9	2293	14.2	5948	15.6	3409	14.2
5601HR	2483	13.5	3586	13.4	2706	14.6	1852	13.6	4210	15.1	2898	14.1
5500HR	2678	13.1	3936	12.7	3020	14.5	2007	13.7	5254	14.6	3216	13.8
5600HR	2607	13.4	3901	13.6	2953	14.5	1936	13.1	4520	15.5	3115	14.0
Lillian	2787	13.4	3974	13.4	2815	14.9	2122	13.5	5042	15.6	3169	14.2
LSD											175	0.2
# Sites	3	3	2	2	5	5	1	1	1	1	12	12

[z]Grain yield expressed as kg ha^{-1}.
[y]Grain protein measured by NIR and expressed as a percentage on 13.5% moisture basis (Williams 1979).

near Glenlea, MB. Reaction to fusarium head blight (caused by *Fusarium* spp.) was assessed in artificially inoculated field tests conducted near Winnipeg, MB. To determine the loose smut [caused by *Ustilago tritici* (Pers.) Rostr.] reaction type, a mixture of the prevalent races T2, T9, T10 and T39 (Nielsen 1987) was injected into florets at anthesis of plants under field conditions. A mixture of the common bunt [*Tilletia laevis* Kuhn in Rabenh., and *T. caries* (DC.) Tul.& C. Tul.] races L1, L16, T1, T6, T13 and T19 (Hoffman and Metzger 1976) was used to inoculate the seed planted in mid-April of each year near Lethbridge, AB. Response to leaf spots [tan spot caused by *Pyrenophora tritici-repentis.* (Died.) Drechs.; Stagonospora blotch caused by *Phaeosphaeria nodorum* (E. Muller) Hedjaroude; and Septoria blotch caused by *Mycosphaerella graminicola* (Fuckel) J. Schrot. in Cohn] was scored in tests grown near Swift Current, Indian Head and Regina, SK, following procedures described by Fernandez et al. (1996). Stem solidness was rated using a scheme described by DePauw and Read (1982).

Performance

Sawfly cutting was light in 2000 to 2002 at Swift Current where Lillian showed significantly less cutting by the wheat-stem sawfly only compared to the hollowed stem cultivar, AC Barrie (Table 1). Where cutting was high near Skiff, AB, in 2002, Lillian was cut significantly less than all checks except the wheat stem sawfly check, AC Abbey. Based on 31 tests in the Western Bread Wheat Cooperative test during 2000 to 2002, Lillian yielded 7.2% ($P \leq 0.05$) more grain than AC Abbey, the wheat stem sawfly check cultivar (Table 2). Lillian produced 8.8% ($P \leq 0.05$) more grain than Neepawa. Lillian was significantly earlier than Superb in 2002 and significantly earlier than Laura on average. The plant height of Lillian was intermediate between Neepawa and AC Abbey with straw strength less than AC Barrie but similar to Laura and AC Abbey. The 3-yr average kernel weight of Lillian was similar to that of AC Barrie, and significantly larger than Laura and AC Abbey. In 2002, the kernel weight of Lillian was significantly less than that of Superb. On average, the volume weight of Lillian was significantly less than AC Barrie and similar to the other two checks. In the semiarid regions Zone 1 and 2 of Saskatchewan, where the wheat stem sawfly is a pest, Lillian ranked #1 and # 2, respectively (Table 3). Averaged across the 12 sites, Lillian yielded significantly more grain and protein than Harvest, and significantly more grain than 5601HR.

Other Characteristics

SPIKES. Fusiform to oblong, mid-dense, mid-long, erect to slightly nodding, apically awnleted; glumes are mid-wide to wide, short to mid-long, glabrous, white; glume shoulders are primarily square, although some tending to oblique, rounded, and elevated, mid-wide to wide; glume beak is very short and slightly curved.

KERNEL: Color is red, medium size, mid-wide, mid-long, elliptical to ovate; cheeks rounded to angular; brush mid-size with mid-size hairs; embryo mid-size and oval to round.

SHATTERING: Resistant to seed shelling due to wind.

DISEASE REACTION: Resistant to prevalent races of leaf and stem rust, moderately resistant to common bunt and loose smut, intermediate resistance to leaf spots, and susceptible to fusarium head blight (Table 4). Lillian has better resistance to leaf rust and leaf spots than AC Abbey.

END-USE SUITABILITY: Based on 3 yr of testing in the Western Bread Wheat Cooperative test (Table 5), Lillian was rated equal to the check cultivars for grain quality by the Quality Evaluation Team of the Prairie Registration Recommending Committee for Grain. Lillian is eligible for all grades of the Canada Western Red Spring wheat class. It expressed elevated grain protein concentration combined with high grain yield (Tables 2, 3 and 5). Lillian expressed only the 1.7 kb band, whereas its parent 90B07-AU2B and

Table 4. Disease reactions of Lillian and check cultivars, based on data from Western Bread Wheat Cooperative test (2000–2002)

	Leaf rust[z]			Stem rust[z]		
	2000	2001	2002	2000	2001	2002
Katepwa	–	35MRMS	80MS	–	2R	3R
Laura	–	TR	TR	0R	TR	TR
AC Abbey	60S	30MRMS	50M	0R	TR	50M
AC Barrie	50MR	40MRMS	55M	0R	TR	55M
AC Elsa	5MRMS	3MR	–	0R	TR	–
Superb	–	–	No data	–		No data
Lillian	5R	5MR	0R	0R	1R	0R

	Bunt[z]			Loose smut[z]		
	2000	2001	2002	2000	2001	2002
Katepwa	–	22MS	TR	–	0R	0R
Laura	47S	42S	16S	33MR	50I	13MR
AC Abbey	4VR	3R	0R	0R	–	7R
AC Barrie	27MS	23MS	3R	3R	0R	50I
AC Elsa	33S	23MS	–	11R	100S	–
Superb	–	–	0R	–	–	65S
Lillian	10MR	10MR	4R	11R	0R	33I

	FHB index[y]			
	2000	2001	2002 Glenlea	2002 Carman
Katepwa	–	15	44	13
Laura	27	40	54	26
AC Abbey	42	34	90	33
AC Barrie	17	13	54	26
AC Elsa	49	55	–	–
Superb	–	–	66	15
Lillian	42	44	86	44

				Leaf spot	
	2000 Melf	2000 SC	2001 Reg[x]	2002 IH[w]	2002 SC[v]
Katepwa	–	–	7.3	9.5	7.5
Laura	7.6	7.5	6.8	8.8	8.2
AC Abbey	9.4	8.5	8.5	11.0	8.2
AC Barrie	8.3	8.0	7.5	9.0	7.7
AC Elsa	7.3	7.3	8.0	–	–
Superb	–	–	–	10.8	7.7
Lillian	6.7	6.8	6.5	8.0	7.3

[z]Percent infection and type of reaction: T, trace; R, resistant; VR, very resistant; M, intermediate resistant MR, moderately resistant; I, intermediate resistant; S, susceptible.
[y]Fusarium head blight index = (% infected spikelets × % infected spikes)/100.
[x]Regina – pathogens isolated from checks and their relative frequency: *Pyrenophora tritici-repentis* = 25% (range 13 to 34%), *Septoria tritici* = 36% (range 10 to 52%), *S. nodorum* = 19% (range 9 to 36%), *S. avenae f. sp. triticea* = 15% (range 4 to 33%), *Cochliobolus sativus* = 5% (range 0 to 9%).
[w]Indian Head – pathogens isolated from checks and their relative frequency: *P. tritici-repentis* 49%, *S. nodorum* 24%, *S. tritici* 7%, *C. sativus* 20%.
[v]Swift Current – pathogens isolated from checks and their relative frequency: *Pyrenophora tritici-repentis* 17%, *Septoria nodorum* 74%, *S. tritici* 5%, *Cochliobolus sativus* 4%.

grandparent ND643 expressed the 1.5 kb and the 1.7 kb bands associated with the NOR protein marker. This suggests that there may have been a recombination between the NOR protein marker and the allele for elevated protein concentration or that the elevated grain protein concentration is conditioned by other genes.

Maintenance and Distribution of Pedigreed Seed

Lillian consists of a composite of 128 Breeder Lines developed from single plants selected at random out of the double haploid line 95B23*NE16, were grown out as Pre-Breeder Lines in 3-m-long rows in isolation near Swift Current in 2001, and again as 15-m rows near Indian Head in 2002. Breeder Seed will be maintained by the Seed Increase Unit of the Research Farm, Indian Head, SK, Canada S0G 2K0. Application for Plant Breeders' Rights has been submitted. The variety will be added to the OECD list of Cultivars. Lillian has been released for distribution and multiplication to SeCan Association, 201 - 52 Antares Drive, Ottawa, ON., K2E 7Z1.

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Table 5. Averages of end-use suitability[z] traits of Lillian and check-cultivars based on Western Bread Wheat Co-operative test (2000–2002)

	Wheat protein (%)	Flour protein (%)	Flour yield (%)	Flour ash (%)	Flour color Agtron	Amylograph viscosity BU	Hagberg Falling no. (s)
Laura	14.7	14.0	74.6	0.42	83.7	577	362
AC Barrie	14.6	14.2	76.7	0.43	77.8	720	413
AC Abbey	14.4	14.0	75.8	0.43	80.8	727	388
Lillian	14.9	14.4	75.6	0.46	78.3	782	398

	Starch damage (megazyme)	Farinograph[y]				Canadian short process		
		Absorption *%)	DDT (min)	MTI (BU)	Stability (min)	LV[x] (cc)	Time (min)	Absorption (%)
Laura	6.4	66.9	8.1	18.3	16.8	1132	10.3	70.3
AC Barrie	7.1	65.4	6.6	25.0	11.2	1088	13.0	69.7
AC Abbey	6.3	67.5	5.9	16.7	14.0	1197	8.6	70.7
Lillian	7.0	68.3	5.3	20.0	11.0	1113	10.0	71.7

[z]American Association of Cereal Chemists methods were followed by the Grain Research Laboratory, Canadian Grain Commission, for determining the various end-use suitability traits on a composite of 6 to 10 locations each year.
[y]DDT is the Farinograph dough development time; MTI is Farinograph mixing tolerance index expressed in Brabender Units (BU).
[x]LV, loaf volume.

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